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NOTE ON THE RED BEDS OF THE RIO GRANDE REGION IN CENTRAL NEW MEXICO[1]

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During the summers of 1904 and 1905 the writer was engaged in geologic investigations in the Rio Grande valley in central New Mexico. The results will be set forth in detail in the near future, but a preliminary statement is here given of certain facts which throw some light on the complex problems of the Red beds.

There are exceptional opportunities for geologic observations in the Rio Grande valley. The region is one in which many monoclinal or block mountains occur, having precipitous, scarp-like faces in which the various geologic formations, ranging in age from pre-Cambrian to Quaternary, are conspicuously exposed. The Red beds here described outcrop at the surface with minor interruptions from Galisteo Creek at the southern end of the Rocky Mountains, southward to Rincon, a distance of about 200 miles. They were examined with care in many places east of the Rio Grande, notably in Galisteo canyon; at the northern end of Sandia mountains; in Abo canyon east of Belen; in the mountains east of Socorro; in San Andreas mountains east of Engle; and in the Caballos-Fra Cristobal range north of Rincon.

Throughout this distance the Red beds are uniform in character, consisting usually of three more or less distinct divisions. The lowest division is composed principally of massive, dark red sandstone, with a maximum observed thickness of about 800 feet. The middle division consists of pink and white shale and gypsum, with a subordinate amount of limestone. The limestone is not always present, and the gypsum varies in thickness. In some places, as in Galisteo canyon at the northern end of the region, the massive gypsum is about 140 feet thick, with the accompanying shale inconspicuous and the limestone practically absent. In other places the gypsum is distributed in thin beds through a considerable thickness of shale and limestone, as is the case in San Andreas Mountains east of Engle, where the gypsiferous division is nearly 1,000 feet thick. The upper division, consisting of alternating layers of yellow, pink, and white sandstones and shales, has an observed thickness of many hundreds of feet, but is not always clearly differentiated from the middle or gypsiferous division.

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[1] Published by permission of the Director of the U. S. Geological Survey.

The Red beds of the Rio Grande region are similar in general appearance and lithologic character to the red sandstone formation occurring along the eastern base of the Rocky Mountains, and extending thence eastward across southern Colorado and New Mexico. In other words the red sandstones and shales of the Rio Grande region form part of the complex which is frequently called "the Red beds" of the Rocky Mountain region.

In the Rio Grande region the Red beds rest unconformably upon an extensive series of Upper Carboniferous limestones. At the base of the red strata occurs a limestone conglomerate, the pebbles of which contain fossils identical with those of the limestones upon which the conglomerate rests. This was observed in the hills east of Socorro, in Abo canyon east of Belen, and at the northern end of Sandia Mountains. Twenty-five to seventy-five feet above this basal conglomerate occurs a persistent limestone member containing a rich fauna. Collections were made from this limestone in several localities.

Many of the limestones of the middle or gypsiferous division are also very fossiliferous, and large collections were obtained from them in widely separated localities. The upper division, so far as observed, is sparingly fossiliferous, and not faunally different from the underlying or middle division. But overlying it in the southern half of the region occurs a limestone several hundred feet thick, which yielded an abundant fauna. This overlying limestone is absent in the northern part of the region, but occurs in the central part and apparently thickens toward the south. It is well-developed in the mountains east of Socorro, in the San Andreas Mountains east of Engle, in the Caballos-Fra Cristobal Range, and elsewhere. On account of its important bearing on the age of the underlying Red beds, fossils were collected from it in about thirty separate localities.

The fossil collections from the various horizons are too voluminous to be described in this note, and discussion of them is reserved for the more extended report to follow. Dr. G. H. Girty,[1] of the Geological Survey, who has examined them, states that the faunas from the Red beds are Upper Carboniferous, although they are sharply distinct from those of the underlying limestones which are also Upper Carboniferous. He states further that the fauna of the limestone overlying the Red beds is also clearly Carboniferous and probably older than the Guadalupian fauna. In other words, all of the 2,000 feet or more of the Red beds just described in the Rio Grande region are Carboniferous, and probably older than the Guadalupian or so-called Permian of western Texas.

No red sediments were observed immediately overlying the uppermost Carboniferous limestone. In some of the southernmost exposures, particularly in the Caballos Mountains, this limestone is overlain by dark-colored shales in which Benton fossils[1] were found about 200 feet above the Carboniferous limestone.

At the northern end of the region in Galisteo canyon the triple division of the Carboniferous Red beds is characteristically developed, although the exposed thickness is much less than it is farther south. Only the upper 250 feet of the lower or massive sandstone division is exposed. The gypsum is here about 140 feet thick; and the upper or pink division, consisting mainly of sandstone, is 300 feet or more in thickness. No fossils were found in the Red beds at this place, but large collections were obtained from the lower division near Tejon, about 12 miles south of Galisteo Creek.

The limestone which overlies the pink sandstones in the southern part of the region, and which has just been described as the highest horizon at which Carboniferous fossils were found, does not occur in Galisteo canyon. About 200 feet of variegated shales and sandstones, having the same general appearance as the Morrison formation, overlie the pink sandstones and are separated from them by what appears to be an unconformity of erosion. This was seen in only one place. The variegated shales are overlain by a massive white friable sandstone about 60 feet thick and similar in appearance to the sandstone which, in eastern Colorado and New Mexico, has frequently been called the lower Dakota, but which, as Stanton[1] has shown, underlies fossiliferous Comanche in the plains region, and in the foothills of the Rocky Mountains at Canyon City, Colo. This sandstone is followed in turn by fossiliferous sandstones, shales, and limestones representing the principal subdivisions of the Upper Cretaceous section of the eastern Rocky Mountain region, with the possible exception of the Dakota.

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[1] Personal communication.

[1] The Cretaceous fossils referred to here and elsewhere in this paper have been identified by Dr. T. W. Stanton.

In the central part of the region described, although known Carboniferous Red beds were observed in several places with fossiliferous Benton in the same section, no red sediments were observed which could be referred to the Triassic. This fact is significant, since Triassic Red beds are known to occur in the Gallinas Mountains,[2] about 60 miles northwest of Galisteo canyon, and in the plains region of eastern Colorado and New Mexico. Triassic vertebrates have been reported by Darton[3] in the Red beds of Purgatory canyon in southeastern Colorado, and by Stanton[4] in the Rio Cimarron canyon of eastern New Mexico. The writer has also found them in the northern breaks of the Staked Plains in eastern New Mexico.

The latter occurrence has not heretofore been described. The fossil bones were found at E. O. Davis' ranch, about 20 miles southeast of Tucumcari. They occur at the top of the Red beds, overlain at this point by plains-Tertiary, but covered half a mile farther north by yellow sandstones and shales containing *Gryphaea corrugata* Say and other characteristic Comanche fossils.

Invertebrates of probable Triassic affinities have been reported from the red beds of the Canadian valley by Stanton,[5] who in company with the writer obtained a collection of them at Henry Hunikes ranch on the Rio Concho, about 30 miles southeast of Las Vegas.

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[1] T. W. Stanton, "The Morrison Formation and Its Relations with the Comanche Series of the Dakota Formation," *Journal of Geology*, Vol. XIII (1905), pp. 657–69.

[2] E. D. Cope, *Monographs*, U. S. Geographical and Geological Surveys West of 100th Meridian, Vol. IV, Part II, "Report upon the Extinct Vertebrata Obtained in New Mexico by Parties of the Expedition of 1874, 1877," pp. 5–13.

[3] N. H. Darton, "Preliminary Report on the Geology and Underground Water Resources of the Central Great Plains," U. S. Geological Survey, *Professional Paper No. 32*, 1905, p. 159.

[4] *Op. cit.*, p. 665.

[5] *Ibid.*, p. 666.

The shells occur about 500 feet below the top of the Red beds as exposed in the Canadian escarpment 5 miles to the west. Stanton[1] states that the collection contains two species belonging probably to the genus *Unio* and comparable, though apparently not identical, with the species of *Unio* described by Meek from the Triassic of Gallinas Creek, New Mexico, and by Simpson from the Dockum beds in western Texas. Regarding the age relations of these invertebrates, Stanton states that "the occurrence of *Unio* in these Red beds is considered sufficient evidence of their post-Paleozoic age, from the fact that the genus is not known to range elsewhere below the Mesozoic, and, with the exception of these forms described by Meek and Simpson, it has not been recorded in beds older than the Jurassic."

Since the Red beds at no great distance both east and west of the Rio Grande region are in part at least Triassic, it is somewhat surprising that all of the 2,000 feet or more of the Rio Grande Red beds (except the late Cretaceous red series described below) should prove to be older than the Permian. It is possible that further investigation may reveal the presence of younger Red beds in localities not yet examined in the Rio Grande region, but, judging from the evidence at hand, it is more probable that, in case Triassic and Permian beds were ever deposited in this region, they were eroded away prior to the deposition of the Upper Cretaceous sediments.

A second or younger red series occurs in the Rio Grande valley which has sometimes been confused with the Carboniferous Red beds just described. It is perhaps best exposed near Elephant Butte, west of Engle, N. M., where it consists of shale, sandstone, and conglomerate more or less highly colored and several hundred feet thick. It is well exposed only where the Rio Grande and its tributary streams have eroded into it between the Caballos and Fra Cristobal Mountains. It is exposed close to a zone of intense faulting, and probably for this reason has been erroneously interpreted as a part of the older or Carboniferous Red beds brought to the surface by faulting.

The red sediments at Elephant Butte are very similar in general appearance to the Carboniferous Red beds, and might be easily mistaken for that formation until examined closely, when they are found to differ in composition from the older beds and to lie stratigraphically above fossiliferous limestones and shales of Upper Cretaceous age. At the northern end of Caballos mountains, two miles south of Elephant Butte, the Upper Carboniferous formations, including the older Red beds, together with their underlying and overlying limestones, occur overlain by fossiliferous strata of the Benton formation, which in turn is followed by an extensive series of Cretaceous sandstones, containing beds of coal at its base, and great quantities of fossil wood at higher horizons. The leaves and tree trunks of both monocotyledonous and dicotyledonous varieties are numerous. Palm wood is particularly abundant.

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[1] Personal communication.

The red sandstones and shales constitute the uppermost exposed member of the coal-bearing sandstones and, in addition to the fossil plants, contain Dinosaur bones. No excavations were made in order to secure satisfactory material for specific determination, but Mr. J. W. Gidley, of the National Museum, who examined the collections, states that the Dinosaurs belong to the genus *Triceratops*, clearly indicating that these red beds are of late Cretaceous age.

A similar series of red sandstones and conglomerates occurs at the northern end of the region, and was observed above the coal-bearing sandstones near Cerillos, and again near the Hagan coal-fields, a few miles south of Cerillos. In both of these localities the red sediments occur at the top of the Upper Cretaceous section and contain great quantities of petrified wood, but are otherwise unfossilferous, so far as known.

The conglomerates of this formation are made up of pebbles, of various igneous and metamorphic rocks, together with limestones containing Carboniferous fossils, and red sandstones similar to those of the older or Carboniferous Red beds. Many of the pebbles are only slightly rounded and were apparently transported but short distances. The upper part of the formation, throughout an exposed thickness of about 200 feet near Hagan, is a conglomerate composed mainly of fragments of andesite.

This formation was originally described by Hayden[1] as the Galisteo sands. On account of the strong resemblance in physical character, stratigraphic position, and general appearance, the Galisteo formation is here regarded as probably a time equivalent of the Triceratops or late Cretaceous red beds of the Elephant Butte region.

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[1] F. H. Hayden, *U. S. Geological Survey of the Territories* for 1867, 1868, and 1869, reprint 1873, p. 166.

In concluding I would emphasize the fact that there are two red formations in the Rio Grande region, which resemble each other so closely in places that careful observation is sometimes necessary in order to distinguish between them; and that neither of these formations belongs to the Jura-Trias or Permian, to which they have frequently been referred, the older one belonging to the Pennsylvanian system, and the younger one to the Upper Cretaceous.

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